CLAIMS

1. An image metrology reference target, comprising:

at least one fiducial mark; and

at least one orientation dependent radiation source disposed in a predetermined spatial relationship with respect to the at least one fiducial mark, the at least one orientation dependent radiation source emanating from an observation surface orientation dependent radiation having at least one detectable property in an image of the reference target that varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a distance between the orientation dependent radiation source and a camera obtaining the image of the reference target.

2. The reference target of claim 1, wherein:

the at least one fiducial mark includes automatic detection means for facilitating an automatic detection of the reference target in the image; and

the at least one orientation dependent radiation source includes bearing determination means for facilitating a determination of at least one of a position and at least one orientation angle of the reference target with respect to the camera.

3. The reference target of claim 1, wherein the at least one fiducial mark includes at least one robust fiducial mark.

4. The reference target of claim 1, wherein the at least one fiducial mark includes at least four fiducial marks disposed in a predetermined relationship with respect to one another.

5. The reference target of claim 4, wherein the at least one orientation dependent radiation source includes at least two orientation dependent radiation sources disposed non-parallel with respect to each other.

6. The reference target of claim 1, wherein the at least one orientation dependent radiation source includes at least two parallel orientation dependent radiation sources.

7. The reference target of claim 6, wherein the at least one detectable property of a first orientation dependent radiation source of the at least two parallel orientation dependent radiation sources varies differently than the at least one detectable property of a second orientation dependent radiation source of the at least two parallel orientation dependent radiation sources as a function of a common rotation angle of the at least two parallel orientation dependent radiation sources.

8. The reference target of claim 1, wherein the reference target includes at least one identifiable physical attribute that uniquely distinguishes the reference target.

9. The reference target of claim 8, wherein the reference target includes at least two different fiducial marks.

10. The reference target of claim 1, further including at least one reflector coupled to the at least one orientation dependent radiation source to reflect radiation that is incident to the reference target and that passes through the at least one orientation dependent radiation source.

11. The reference target of claim 1, wherein:

the reference target has an essentially planar surface; and

the observation surface of the at least one orientation dependent radiation source is essentially parallel with the planar surface of the reference target.

12. The reference target of claim 1, wherein the at least one detectable property of the at least one orientation dependent radiation source includes a spatial distribution of the orientation dependent radiation on the observation surface that varies as a function of at least one of the rotation angle of the orientation dependent radiation source and the distance between the orientation dependent radiation source and the camera.

13. The reference target of claim 12, wherein the spatial distribution of the orientation dependent radiation on the observation surface includes at least one Moire pattern.

14. The reference target of claim 12, wherein the spatial distribution of the orientation dependent radiation on the observation surface includes an essentially triangular waveform.

15. The reference target of claim 1, wherein the at least one detectable property of the at least one orientation dependent radiation source includes at least one of a position of the orientation dependent radiation on the observation surface, a spatial period of the orientation dependent radiation, a polarization of the orientation dependent radiation, and a wavelength of the orientation dependent radiation.

16. The reference target of claim 1, wherein the at least one orientation dependent radiation source includes:

a first grating having a first spatial frequency; and

a second grating, coupled to the first grating, having a second spatial frequency.

17. The reference target of claim 16, wherein the at least one orientation dependent radiation source further includes an essentially transparent substrate disposed between the first grating and the second grating.

18. The reference target of claim 16, wherein the first spatial frequency and the second spatial frequency are different.

19. The reference target of claim 16, wherein the first spatial frequency and the second spatial frequency are the same.

20. The reference target of claim 1, wherein:

the at least one orientation dependent radiation source includes a first orientation dependent radiation source and a second orientation dependent radiation source;

the observation surface of each orientation dependent radiation source has a primary axis along which the at least one first detectable property varies and a secondary axis orthogonal to the primary axis; and

the first and second orientation dependent radiation sources are oriented such that the secondary aces of the first and second orientation dependent radiation sources are orthogonal to each other.

21. The reference target of claim 20, wherein:

the reference target has a center; and

the first and second orientation dependent radiation sources are oriented such that the secondary axes of the first and second orientation dependent radiation sources each passes through the center of the reference target.

22. The reference target of claim 1, wherein:

the at least one orientation dependent radiation source includes a first orientation dependent radiation source and a second orientation dependent radiation source disposed parallel with respect to each other;

the first orientation dependent radiation source includes:

a first front grating having a first spatial frequency; and

a first back grating, coupled to the first front grating, having a second spatial frequency that is greater than the first spatial frequency; and

the second orientation dependent radiation source includes:

a second front grating having a third spatial frequency; and

a second back grating, coupled to the second front grating, having a fourth spatial frequency that is less than the third spatial frequency.

23. The reference target of claim 1, further including at least one automatically readable coded pattern coupled to the reference target, the automatically readable coded pattern including coded information relating to at least one physical property of the reference target.

24. The reference target of claim 0, wherein the at least one physical property of the reference target includes at least one of relative spatial positions of the at least one fiducial mark and the at least one orientation dependent radiation source, a size of the reference target, a size of the at least one orientation dependent radiation source, and a unique identifying attribute of the reference target.

25. The reference target of claim 0, wherein the at least one automatically readable coded pattern includes a bar code affixed to the reference target.

26. An apparatus, comprising:

at least one orientation dependent radiation source to emanate from an observation surface orientation dependent radiation having at least one detectable property that varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a

distance between the orientation dependent radiation source and a radiation detection device receiving the orientation dependent radiation.

27. The apparatus of claim 26, wherein the at least one detectable property of the at least one orientation dependent radiation source includes a spatial distribution of the orientation dependent radiation on the observation surface that varies as a function of at least one of the rotation angle of the orientation dependent radiation source and the distance between the orientation dependent radiation source and the radiation detection device.

28. The apparatus of claim 27, wherein the spatial distribution of the orientation dependent radiation on the observation surface includes at least one Moire pattern.

29. The apparatus of claim 27, wherein the spatial distribution of the orientation dependent radiation on the observation surface includes an essentially triangular waveform.

30. The apparatus of claim 26, wherein the at least one detectable property of the at least one orientation dependent radiation source includes at least one of a position of the orientation dependent radiation on the observation surface, a spatial period of the orientation dependent radiation, a polarization of the orientation dependent radiation, and a wavelength of the orientation dependent radiation.

31. The apparatus of claim 26, wherein the at least one orientation dependent radiation source includes:

a first grating having a first spatial frequency; and

a second grating, coupled to the first grating, having a second spatial frequency.

32. The apparatus of claim 31, wherein the at least one orientation dependent radiation source further includes an essentially transparent substrate disposed between the first grating and the second grating.

33. The apparatus of claim 31, wherein the first spatial frequency and the second spatial frequency are different.

34. The apparatus of claim 31, wherein the first spatial frequency and the second spatial frequency are the same.

35. A method for processing an image including at least one orientation dependent radiation source that emanates from an observation surface orientation dependent radiation having at least a first detectable property in the image and a second detectable property in the image that each varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a distance between the orientation dependent radiation source and a camera obtaining the image of the at least one orientation dependent radiation source, the method comprising acts of:

determining the rotation angle of the orientation dependent radiation source from the first detectable property; and

determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property.

36. The method of claim 35, wherein the at least one orientation dependent radiation source includes at least two parallel orientation dependent radiation sources, wherein each of the at least first and second properties of one of the at least two parallel orientation dependent radiation sources varies differently than the respective at least first and second properties of another of the at least two parallel orientation dependent radiation sources,

and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of:

determining a common rotation angle of the at least two parallel orientation dependent radiation sources based on a comparison of the respective first detectable properties of the at least two parallel orientation dependent radiation sources,

and wherein the act of determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property includes an act of:

determining a common distance between the at least two parallel orientation dependent radiation sources and the camera based at least on a comparison of the respective second detectable properties of the at least two parallel orientation dependent radiation sources.

37. The method of claim 35, wherein the first detectable property includes a detectable phase of the orientation dependent radiation, wherein the second detectable property includes a detectable spatial frequency of the orientation dependent radiation, and wherein:

the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable phase; and

the act of determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property includes an act of determining the distance from the detectable spatial frequency and the rotation angle.

38. The method of claim 37, wherein the first detectable property includes a detectable position of the orientation dependent radiation on the observation surface, and wherein the act of determining the rotation angle of the orientation dependent radiation source from

the first detectable property includes an act of determining the rotation angle from the detectable position.

39. A computer readable medium encoded with a program for execution on at least one processor, the program, when executed on the at least one processor, performing a method for processing an image including at least one orientation dependent radiation source that emanates from an observation surface orientation dependent radiation having at least a first detectable property in the image and a second detectable property in the image that each varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a distance between the orientation dependent radiation source and a camera obtaining an image of the at least one orientation dependent radiation source, the method comprising acts of:

determining the rotation angle of the orientation dependent radiation source from the first detectable property; and

determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property.

40. The computer readable medium of claim 39, wherein the at least one orientation dependent radiation source includes at least two parallel orientation dependent radiation sources, wherein each of the at least first and second properties of one of the at least two parallel orientation dependent radiation sources varies differently than the respective at least first and second properties of another of the at least two parallel orientation dependent radiation sources, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of:

determining a common rotation angle of the at least two parallel orientation dependent radiation sources based on a comparison of the respective first detectable properties of the at least two parallel orientation dependent radiation sources,

and wherein the act of determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property includes an act of:

determining a common distance between the at least two parallel orientation dependent radiation sources and the camera based at least on a comparison of the respective second detectable properties of the at least two parallel orientation dependent radiation sources.

41. The computer readable medium of claim 39, wherein the first detectable property includes a detectable phase of the orientation dependent radiation, wherein the second detectable property includes a detectable spatial frequency of the orientation dependent radiation, and wherein:

the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable phase; and

the act of determining the distance between the orientation dependent radiation source and the camera from at least the second detectable property includes an act of determining the distance from the detectable spatial frequency and the rotation angle.

42. The computer readable medium of claim 41, wherein the first detectable property includes a detectable position of the orientation dependent radiation on the observation surface, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable position.

43. In a system including at least one orientation dependent radiation source that emanates from an observation surface orientation dependent radiation having at least a first detectable property and a second detectable property that each varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a distance between the orientation dependent radiation source and a radiation detection device receiving the orientation dependent radiation, a method comprising acts of:

determining the rotation angle of the orientation dependent radiation source from the first detectable property; and

determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property.

44. The method of claim 43, wherein the at least one orientation dependent radiation source includes at least two parallel orientation dependent radiation sources, wherein each of the at least first and second properties of one of the at least two parallel orientation dependent radiation sources varies differently than the respective at least first and second properties of another of the at least two parallel orientation dependent radiation sources, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of:

determining a common rotation angle of the at least two parallel orientation dependent radiation sources based on a comparison of the respective first detectable properties of the at least two parallel orientation dependent radiation sources,

and wherein the act of determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property includes an act of:

determining a common distance between the at least two parallel orientation dependent radiation sources and the radiation detection device based at least on a comparison of the

respective second detectable properties of the at least two parallel orientation dependent radiation sources.

45. The method of claim 43, wherein the first detectable property includes a detectable phase of the orientation dependent radiation, wherein the second detectable property includes a detectable spatial frequency of the orientation dependent radiation, and wherein:

the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable phase; and

the act of determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property includes an act of determining the distance from the detectable spatial frequency and the rotation angle.

46. The method of claim 45, wherein the first detectable property includes a detectable position of the orientation dependent radiation on the observation surface, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable position.

47. A computer readable medium encoded with a program for execution on at least one processor, the program, when executed on the at least one processor, performing a method in a system including at least one orientation dependent radiation source that emanates from an observation surface orientation dependent radiation having at least a first detectable property and a second detectable property that each varies as a function of at least one of a rotation angle of the orientation dependent radiation source and a distance

between the orientation dependent radiation source and a radiation detection device receiving the orientation dependent radiation, the method comprising acts of:

determining the rotation angle of the orientation dependent radiation source from the first detectable property; and

determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property.

48. The computer readable medium of claim 47, wherein the at least one orientation dependent radiation source includes at least two parallel orientation dependent radiation sources, wherein each of the at least first and second properties of one of the at least two parallel orientation dependent radiation sources varies differently than the respective at least first and second properties of another of the at least two parallel orientation dependent radiation sources, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of:

determining a common rotation angle of the at least two parallel orientation dependent radiation sources based on a comparison of the respective first detectable properties of the at least two parallel orientation dependent radiation sources,

and wherein the act of determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property includes an act of:

determining a common distance between the at least two parallel orientation dependent radiation sources and the radiation detection device based at least on a comparison of the respective second detectable properties of the at least two parallel orientation dependent radiation sources.

49. The computer readable medium of claim 47, wherein the first detectable property includes a detectable phase of the orientation dependent radiation, wherein the second detectable property includes a detectable spatial frequency of the orientation dependent radiation, and wherein:

the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable phase; and

the act of determining the distance between the orientation dependent radiation source and the radiation detection device from at least the second detectable property includes an act of determining the distance from the detectable spatial frequency and the rotation angle.

50. The computer readable medium of claim 50, wherein the first detectable property includes a detectable position of the orientation dependent radiation on the observation surface, and wherein the act of determining the rotation angle of the orientation dependent radiation source from the first detectable property includes an act of determining the rotation angle from the detectable position.

51. An image metrology reference target, comprising:

automatic detection means for facilitating an automatic detection of the reference target in an image of the reference target obtained by a camera; and

bearing determination means for facilitating a determination of at least one of a position and at least one orientation angle of the reference target with respect to the camera.

52. The reference target of claim 0, wherein:

the automatic detection means includes at least one robust fiducial mark; and

the bearing determination means includes at least one orientation dependent radiation source disposed in a predetermined spatial relationship with respect to the at least one fiducial

mark, the at least one orientation dependent radiation source emanating from an observation surface orientation dependent radiation having at least one detectable property in the image of the reference target that varies as a function of at least one of a viewing angle of the orientation dependent radiation source and a distance between the orientation dependent radiation source and the camera obtaining the image of the reference target.

53. The reference target of claim 52, wherein:

the at least one fiducial mark includes at least four fiducial marks; and

the at least one orientation dependent radiation source includes at least two orientation dependent radiation sources.